

Motor Cortex & Cortical Control of Motor Function

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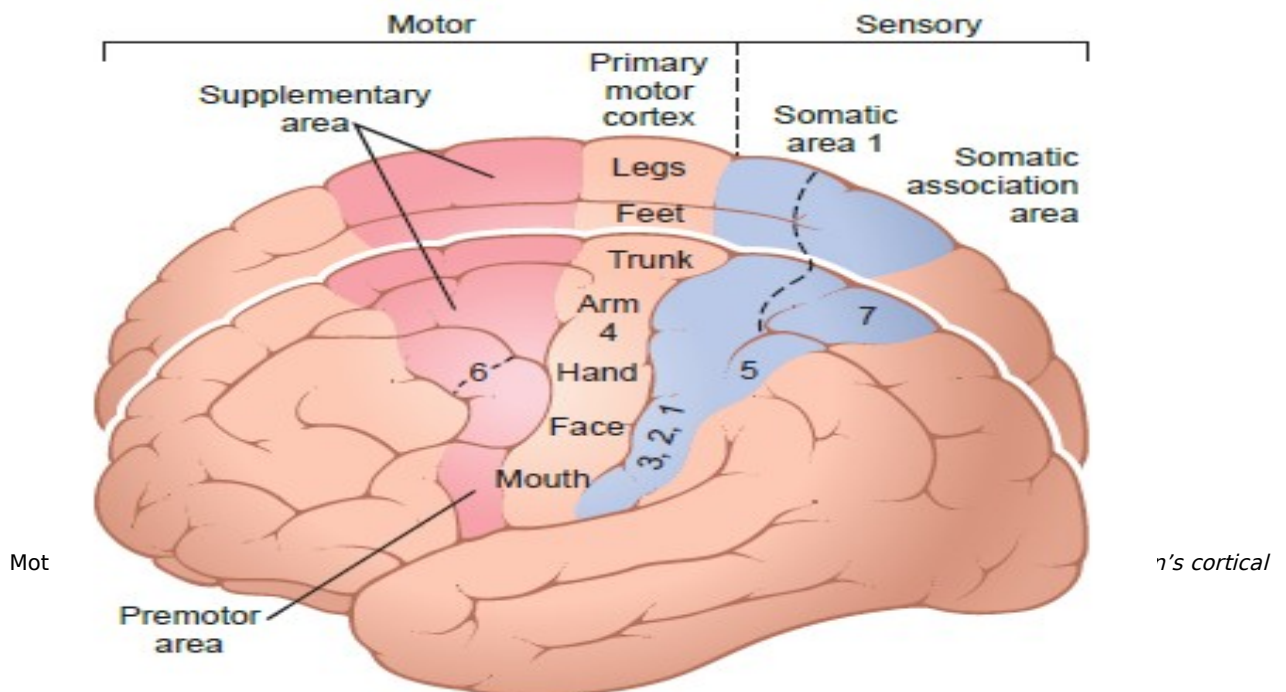
By the end of this lecture the student will be able to:

- ✓ List the cortical motor areas (primary, premotor, supplementary), their characteristics, functions & the effects of their lesions.
- ✓ Explain the importance of the related cortical structures located within the motor area 6 & their specific functions.
- ✓ Describe Prefrontal association area and list its functions.
- ✓ Describe the cortical control over the motor function.
- ✓ Describe cortical plasticity.

Cortical motor areas

The 3 cortical motor areas are:

1. Motor area **4** = Primary motor area.
2. Motor area **6** = Premotor area.



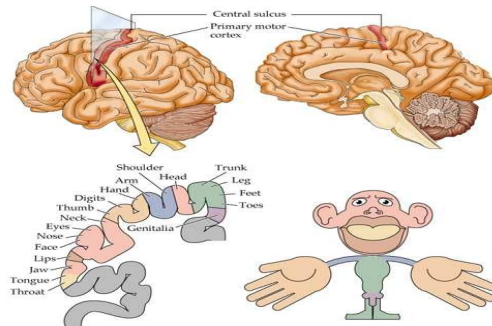
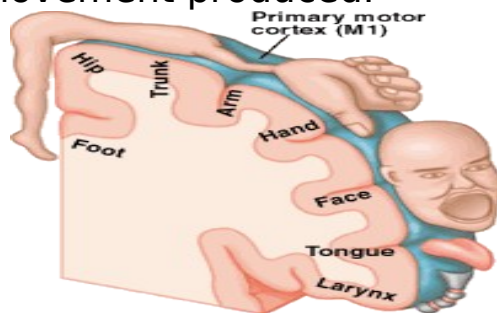
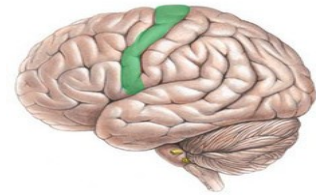
3. **Medial area 6** = Supplementary motor area.

Motor area 4: (primary motor cortex)

Site: Precentral gyrus in frontal lobe.

Topographical representation:

- Inverted (head down and legs up).
- Crossed.
- Area of representation is proportional to the skilled movement produced.



The motor homunculus in primary motor cortex. <https://brainconnection.brainhq.com/2013/03/05/the-anatomy-of-movement/>

Functions	Effects of Lesion
1- Initiation of fine discrete movements of the opposite side of the body e.g. fingers.	1- Loss of fine movements of opposite side of body in the form of monoplegia (localized).
2- Shares in initiation of gross movements of the opposite side.	2- Only weakness or paresis.
3- Facilitatory to the stretch reflex.	3- Hypotonia and Hyporeflexia.
4- Necessary for superficial reflexes (abdominal, cremastic and plantar reflex).	4- Loss of abdominal and cremastic reflex. 5- Partial Babiniski's sign: dorsiflexion of the big toe on scratching lateral aspect of the

	foot.
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Motor area 6 (Premotor area)

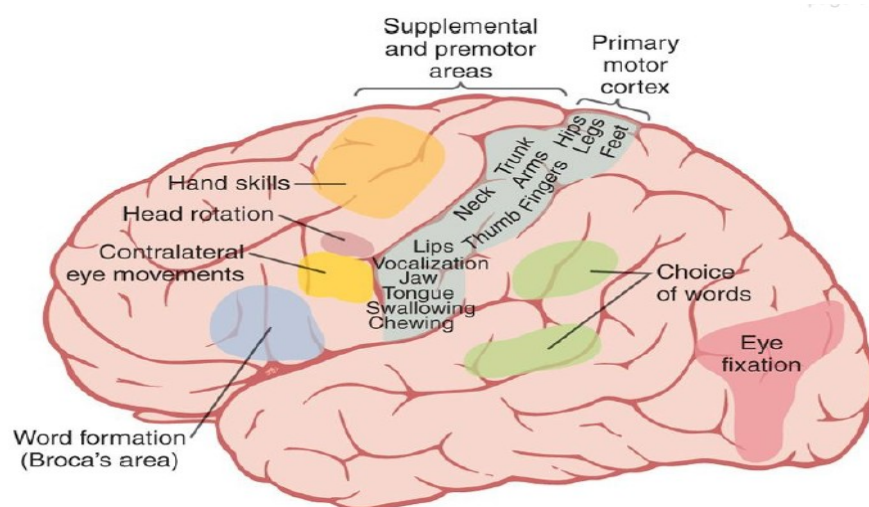
Site: In front of motor area 4 on lateral aspect of frontal lobe (part of premotor cortex).

Topographical representation: is inverted and crossed.

Functions	Effects of Lesion
1- Controls gross movements of the opposite side of body (big joints and limbs).	1- Paresis i.e weakness of voluntary movements But not paralysis.
2- Contains memory for fine skilled movements.	2- Motor apraxia (inability to do skilled movement inspite of absence of paralysis).
3- Together with basal ganglia regulates automatic subconscious associated movements.	3- Loss of automatic associated movements(e.g. swinging of arms).
4- Inhibition of spinal reflexes (e.g. Inhibitory to stretch reflex & grasp reflex).	4- Increased muscle tone Spasticity (hypertonia) & Hyperreflexia & Appearance of grasp reflex.
5- Produces planter flexion of the lateral 4 toes (planter reflex).	5- Partial Babiniski's sign: Fanning of outer four toes.

Specialized areas in the premotor cortex

Representation of the different muscles of the body in the motor cortex and location of other cortical areas responsible for specific types of motor movements. Guyton and Hall 13rd ed.



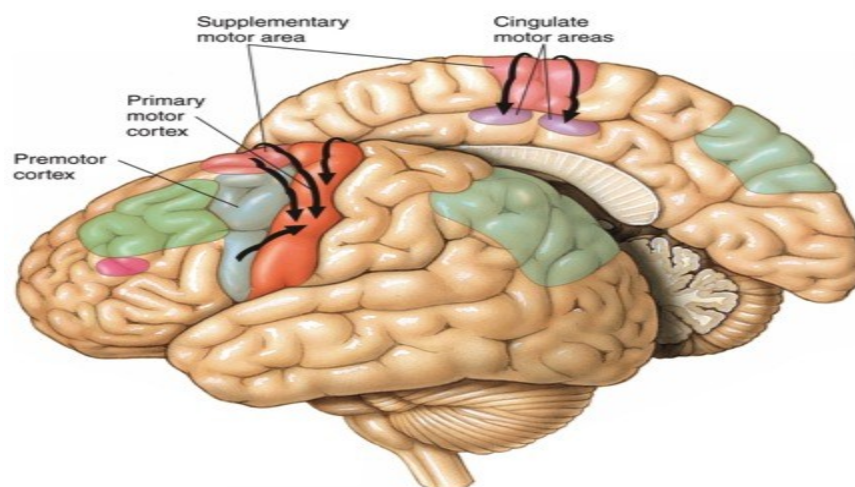
Supplementary motor area = medial area 6

Site: Medial surface of premotor cortex (superior to area 6).

Functions:

1- It supplements (helps) area 6 in the control of voluntary movements of the proximal parts of the body (gross movements) as a background for fine hand or feet movements.

2- It plays a role in planning of movements before they start specially complex and bilateral movements.



[https://](https://brainconnection.brainhq.com/2013/03/05/the-anatomy-of-movement)

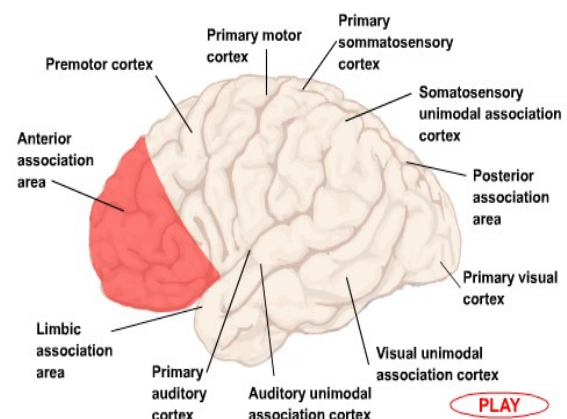
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The prefrontal association area: Anterior association area

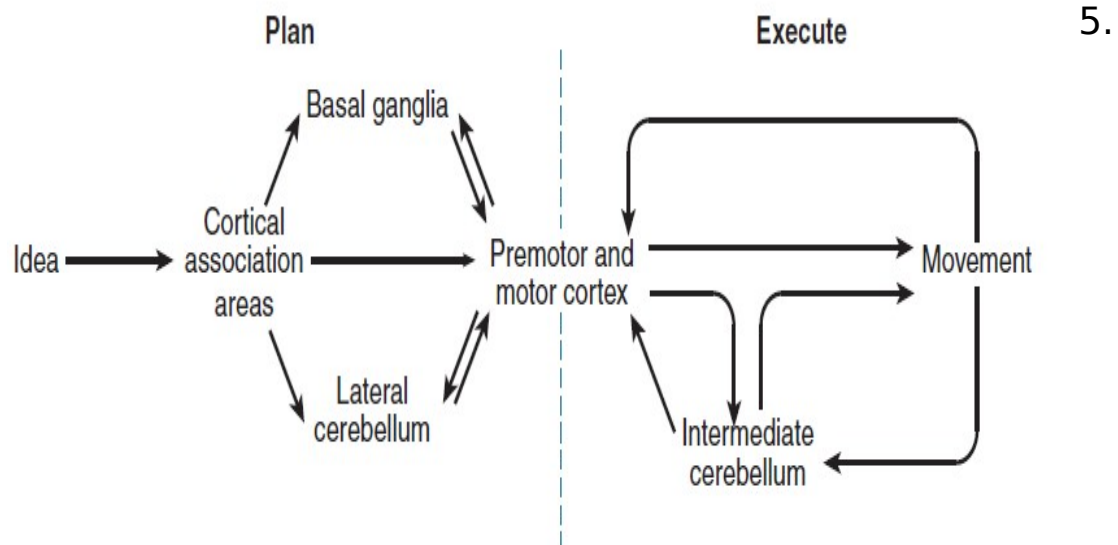
Site: It lies in frontal lobe anterior to premotor area.

Function:

1. Elaboration of **thoughts** and **ideas**.
2. Because of its close association with the **motor cortex** it shares in planning complex patterns and sequences of motor movements.
3. As it contains **Broca's Area** (motor speech center) it plans and stores programs of motor patterns for expressing individual words.



4. Due to its connection to **hippocampus** it is involved in recent memory.



Due to its connection with the **limbic system** it shares in the control of emotional behavior.

Cortical control over the motor function (MOTOR HIERARCHY):

Control of voluntary movement: Commands for voluntary movement originate in cortical association areas. The cortex, basal ganglia, and cerebellum work cooperatively to plan movements. Movement executed by the cortex is relayed via the corticospinal tracts and corticobulbar tracts to motor neurons. The cerebellum provides feedback to adjust and smooth movement. Ganong 24th ed.

The control of movement by the central nervous system is a ***complicated process*** that **involves multiple regions of the brain**:

1. Generation of **idea** occurs in the **prefrontal cortex**.
2. **Awareness** of the surrounding environment and position in space. This information is generated through **somatosensory, visual and auditory sensory** inputs to the posterior parietal cortex.
3. **Motivation** and past memories regulating the behavior takes place either rewarding or stopping the desire in the **limbic system**.
4. **Plan or program** performed in the **basal ganglia, cerebellum, premotor cortex (PMC)** and **supplementary motor areas (SMA)**.
5. **Execution** of motor orders through the cortex is relayed via the corticospinal tracts and corticobulbar tracts to motor neurons.

Cortical Plasticity

The motor cortex shows the same kind of plasticity as already described for the sensory cortex.

For example:

-The finger areas of the contralateral motor cortex enlarge as a pattern of rapid finger movement is learned with the fingers of one hand; this change is detectable at 1 week and maximal at 4 weeks.

- When a limb is amputated its area of representation in the brain become not useless, but expansion of the neighboring area representing other body parts to this area occur.

-When a small focal ischemic lesion is produced in the hand area of the motor cortex of monkeys, the hand area may reappear, with return of motor function, in an adjacent undamaged part of the cortex.

- ✓ Thus, the maps of the motor cortex are not immutable, and they change with experience.

SUGGESTED TEXTBOOKS:

1. Ganong's review of medical physiology 25th edition
2. Gyuton and Hall 13th edition